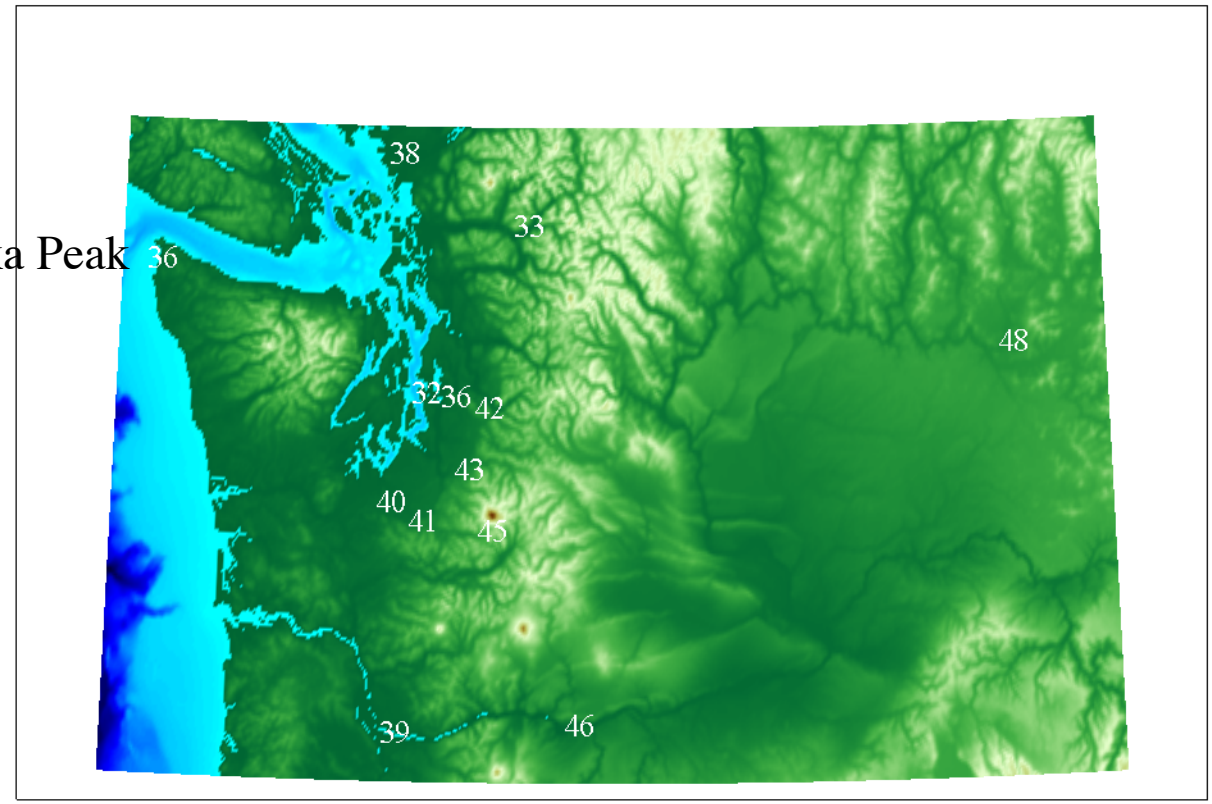
Surface ozone and satellite tropospheric NO_2 for Washington and California

Todd Mitchell, Joel Thornton, and Mike Wallace
University of Washington

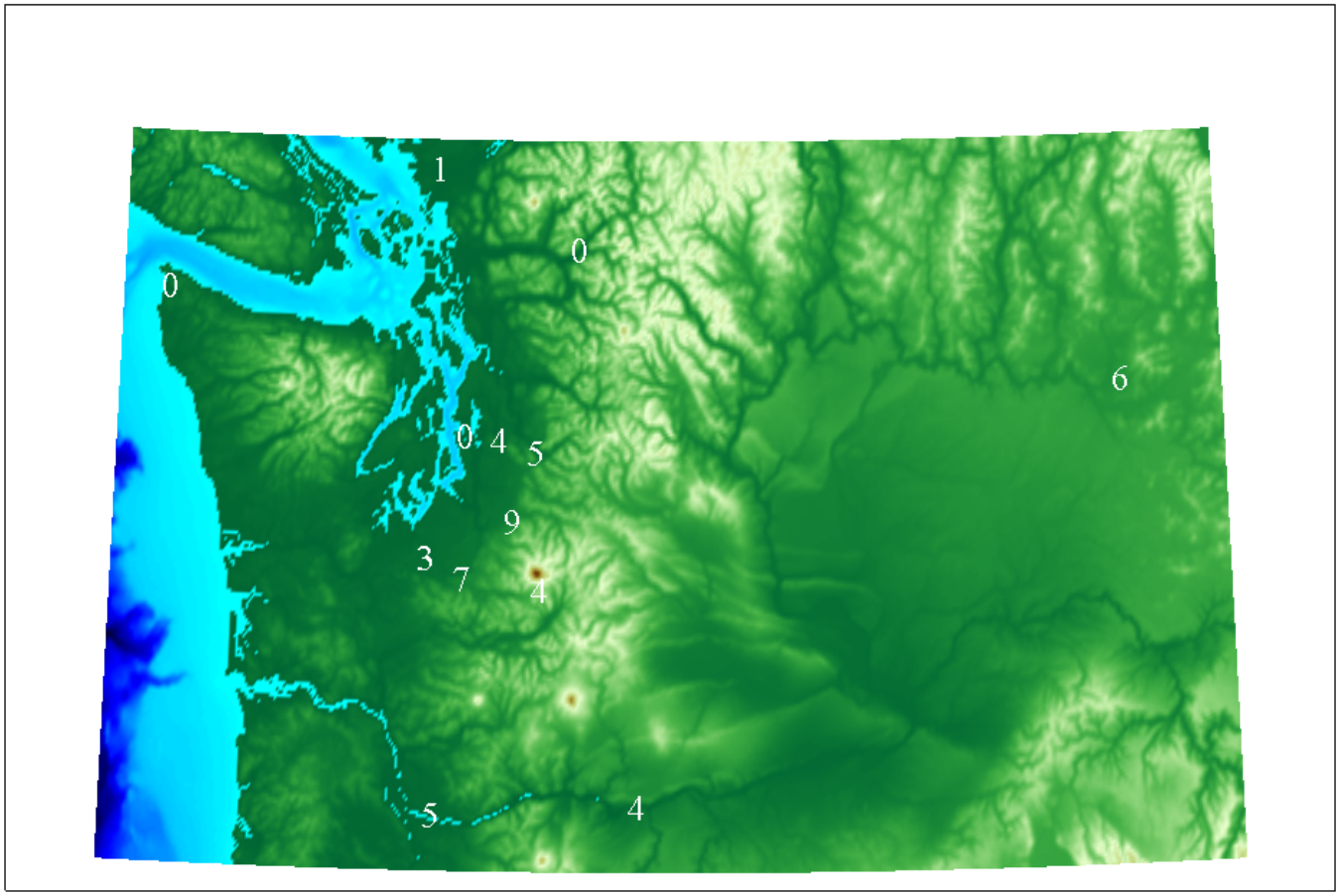
Daily 8-hour maximum surface ozone

Mean May through October ozone (ppb) 1995-2009



Mostly Washington State Department of Ecology measurements served by the Puget Sound Clean Air Agency

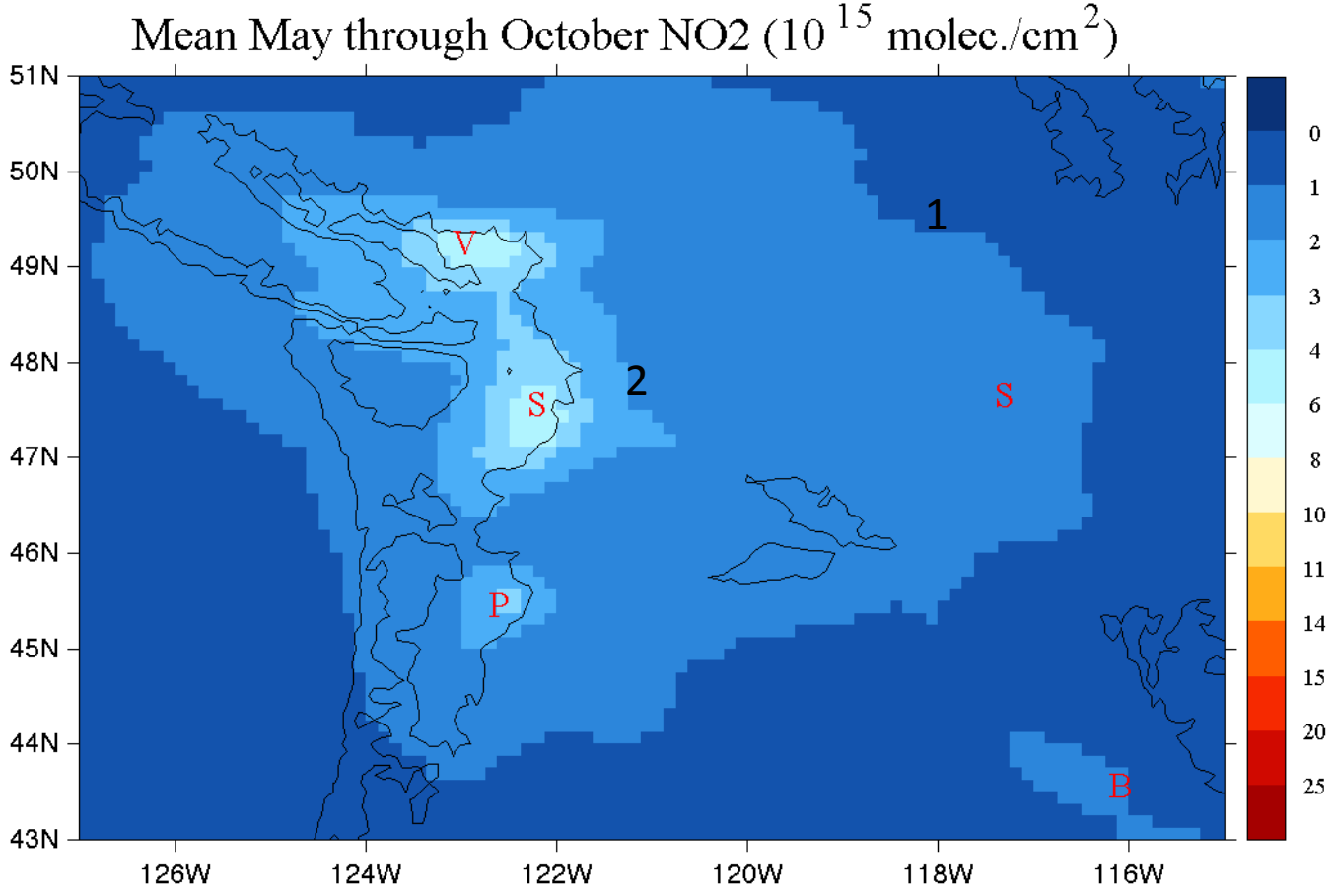
Percent May through October days when ozone > 70 ppb



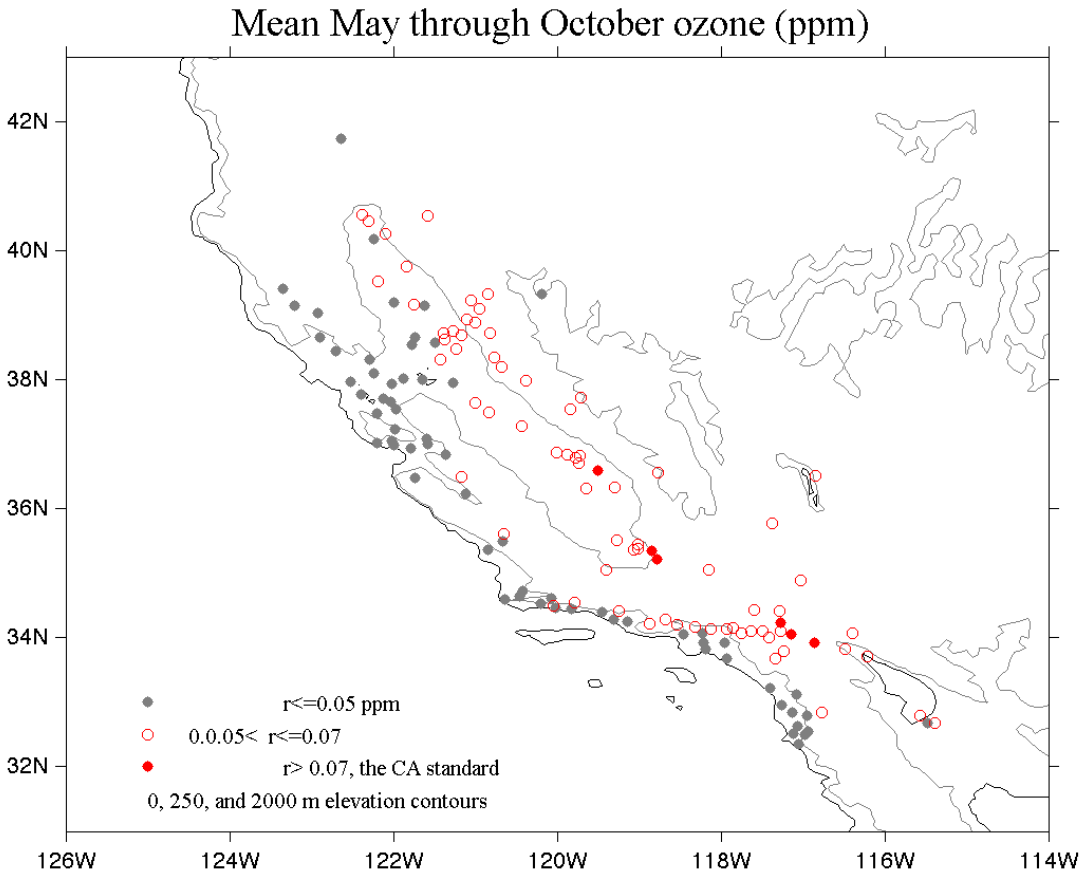
The health consequences of surface ozone

- Even relatively low levels of ozone can cause health effects.
- People with lung disease, children, older adults, and people who are active outdoors may be particularly sensitive to ozone.
- Children are at greatest risk from exposure to ozone because their lungs are still developing and they are more likely to be active outdoors when ozone levels are high, which increases their exposure. Children are also more likely than adults to have asthma.
- It can worsen bronchitis, emphysema, and asthma. Ground level ozone also can reduce lung function and inflame the linings of the lungs. Repeated exposure may permanently scar lung tissue.

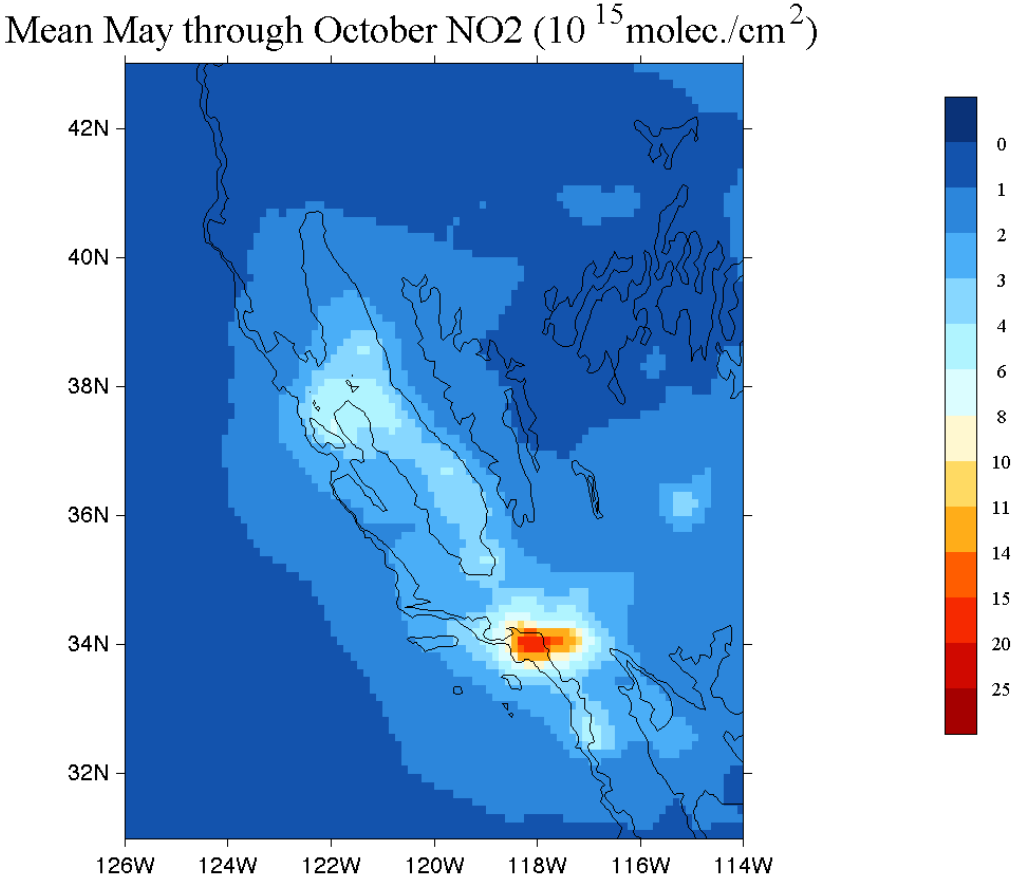
Dutch Ozone Monitoring Instrument NO_2 (DOMINO) tropospheric vertical column NO_2, began in 2005



California daily 8-hour maximum surface ozone

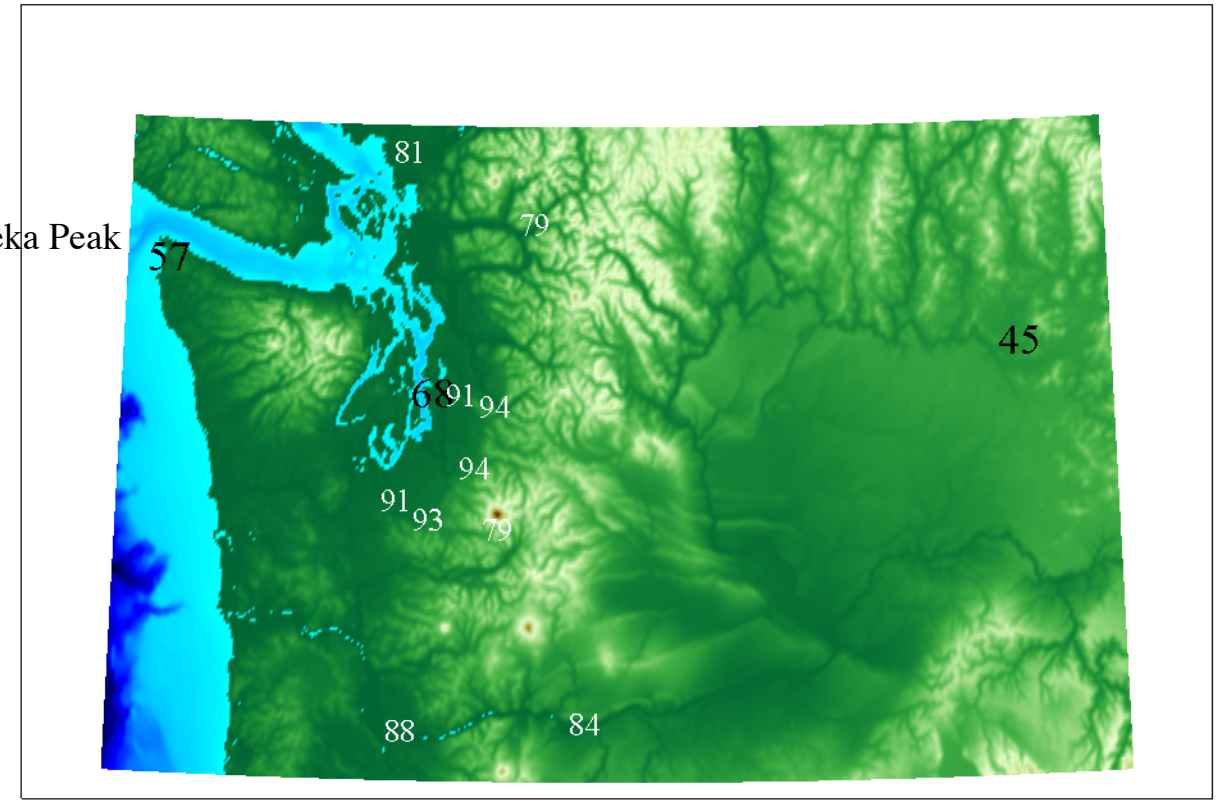


Dutch Ozone Monitoring Instrument NO_2 (DOMINO)
Tropospheric vertical column NO_2, began in 2005

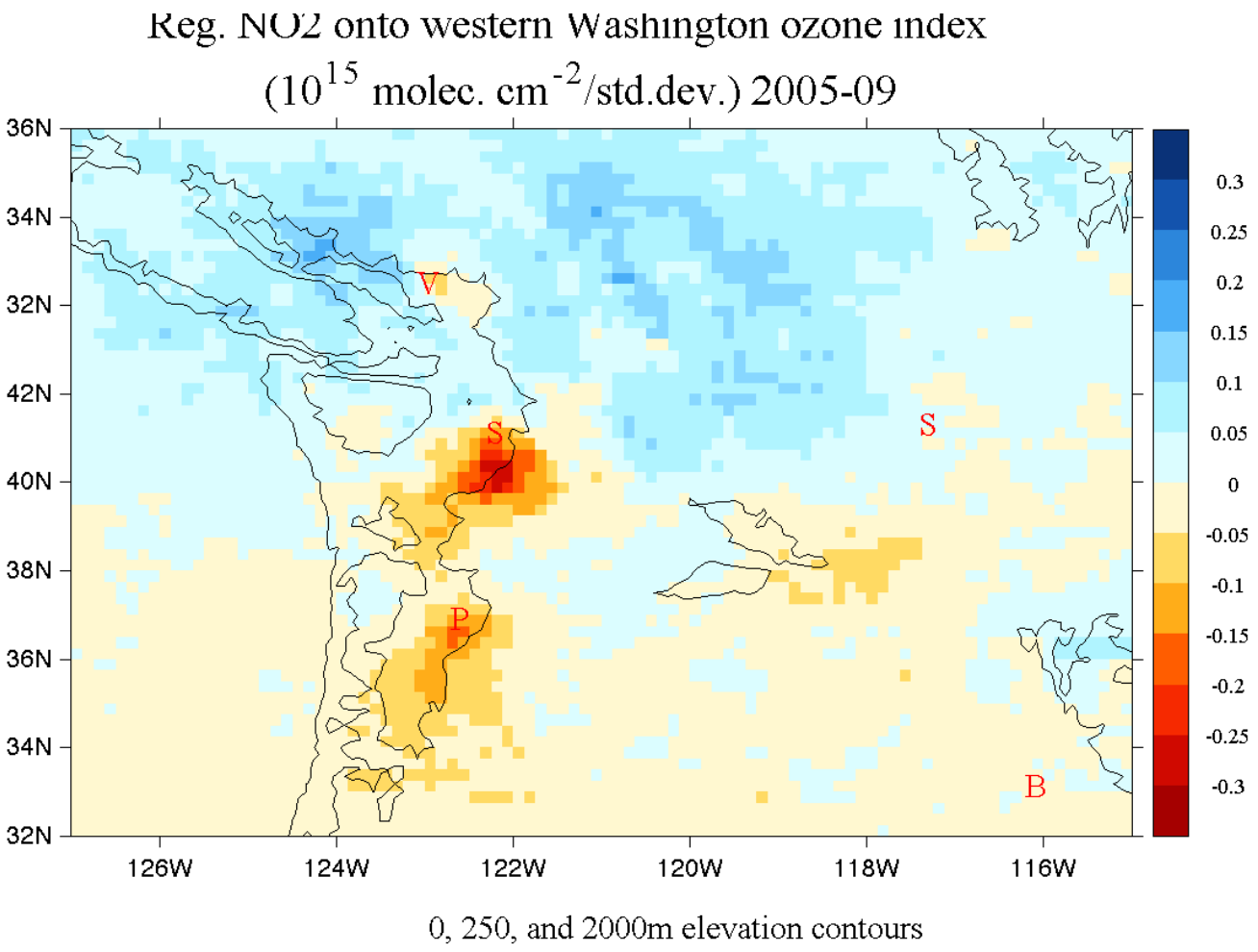


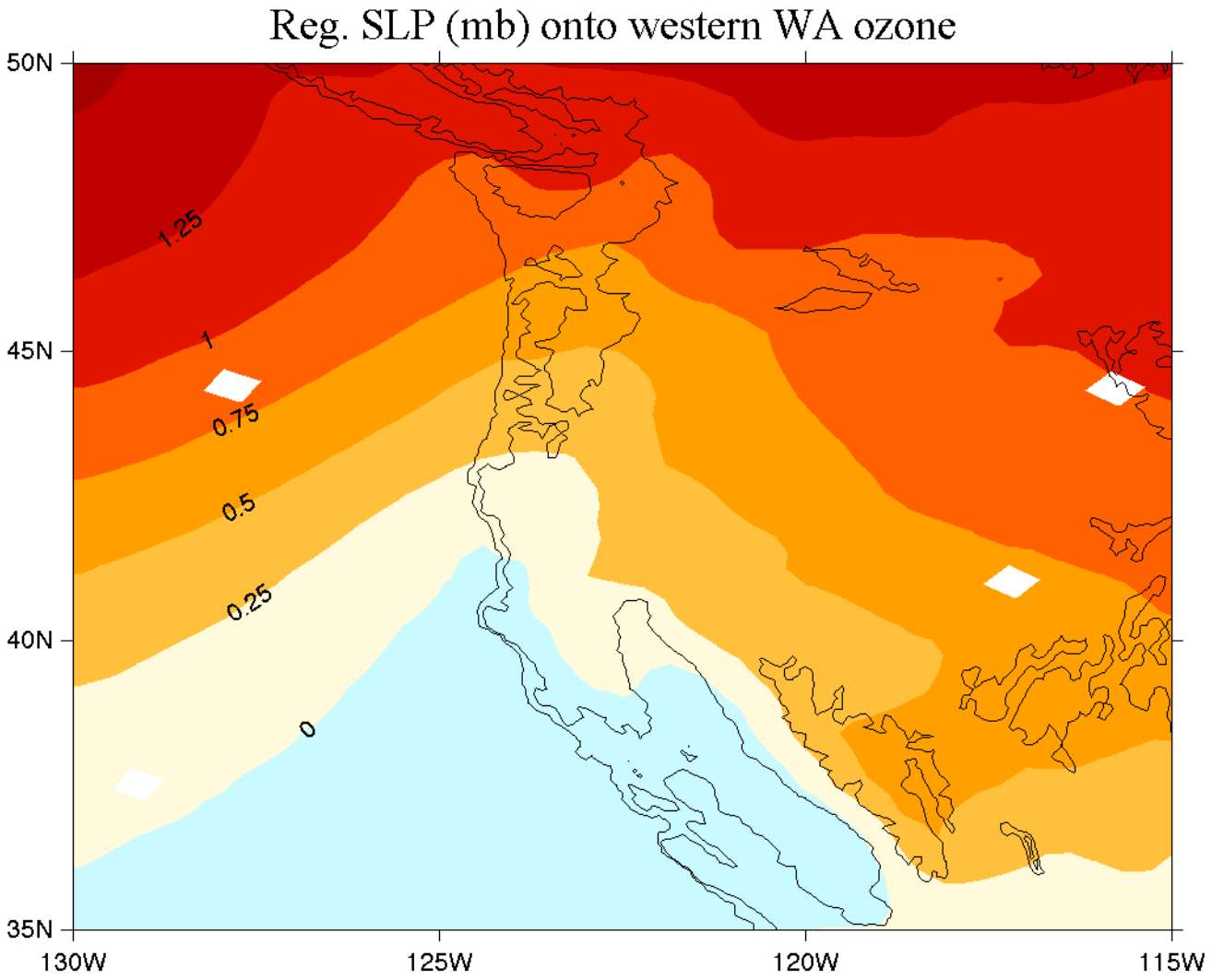
Now look at the daily variability of ozone, NO2, and the atmospheric circulation.

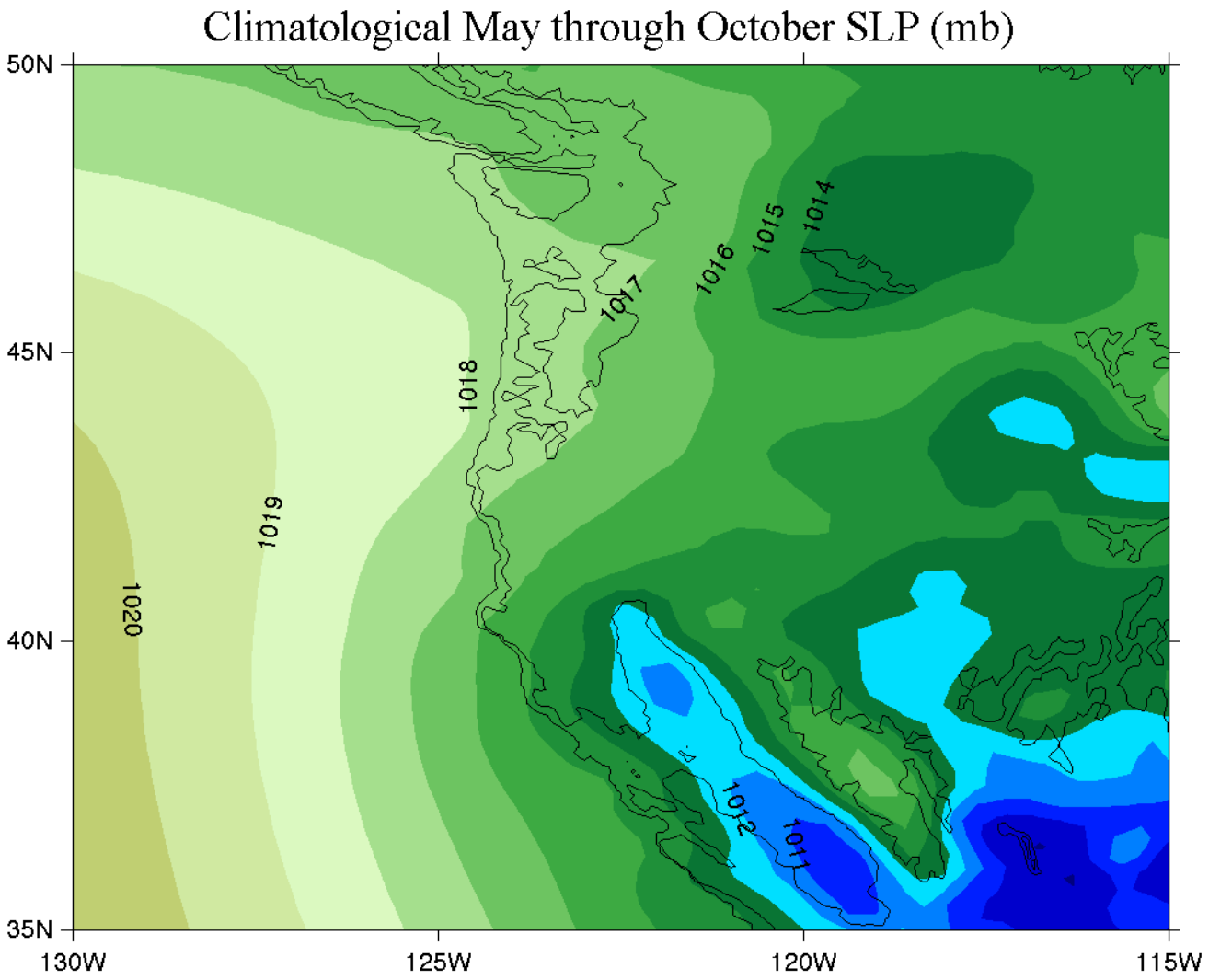
Correlation of daily summertime ozone with state average ozone, 1995-2009

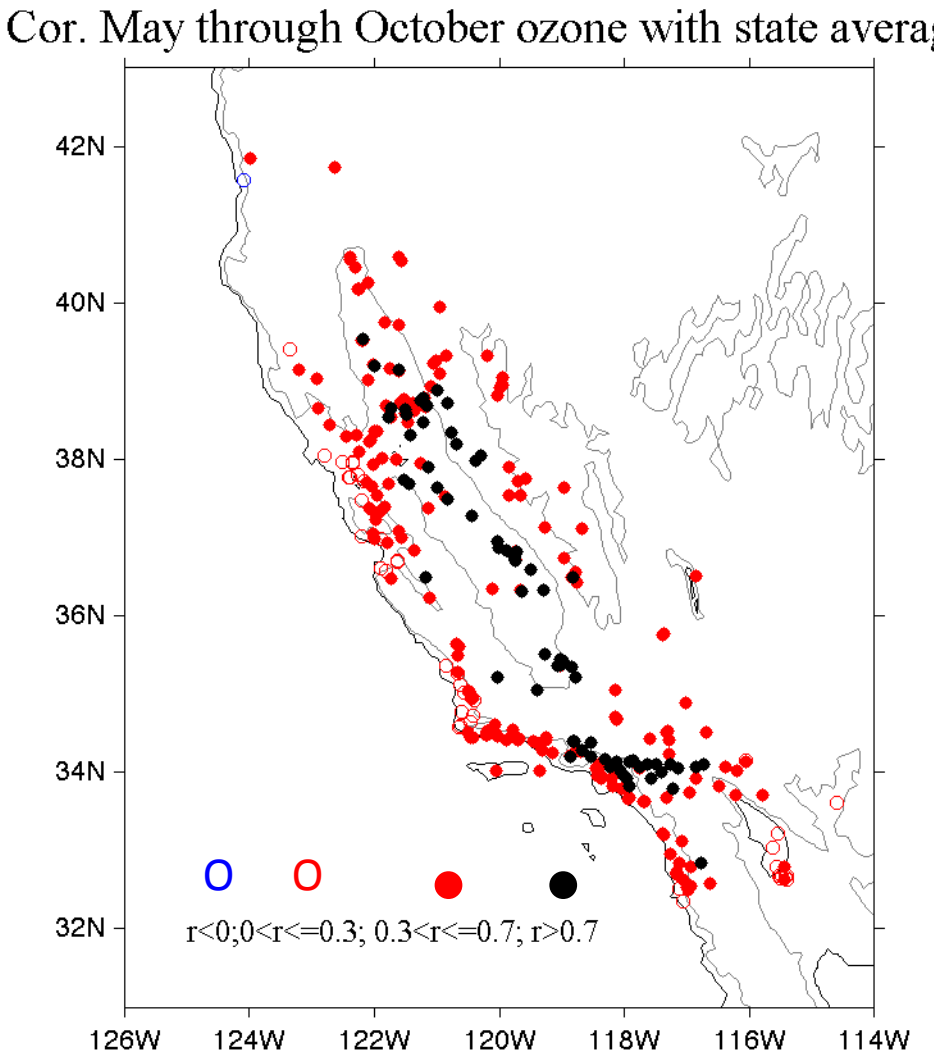


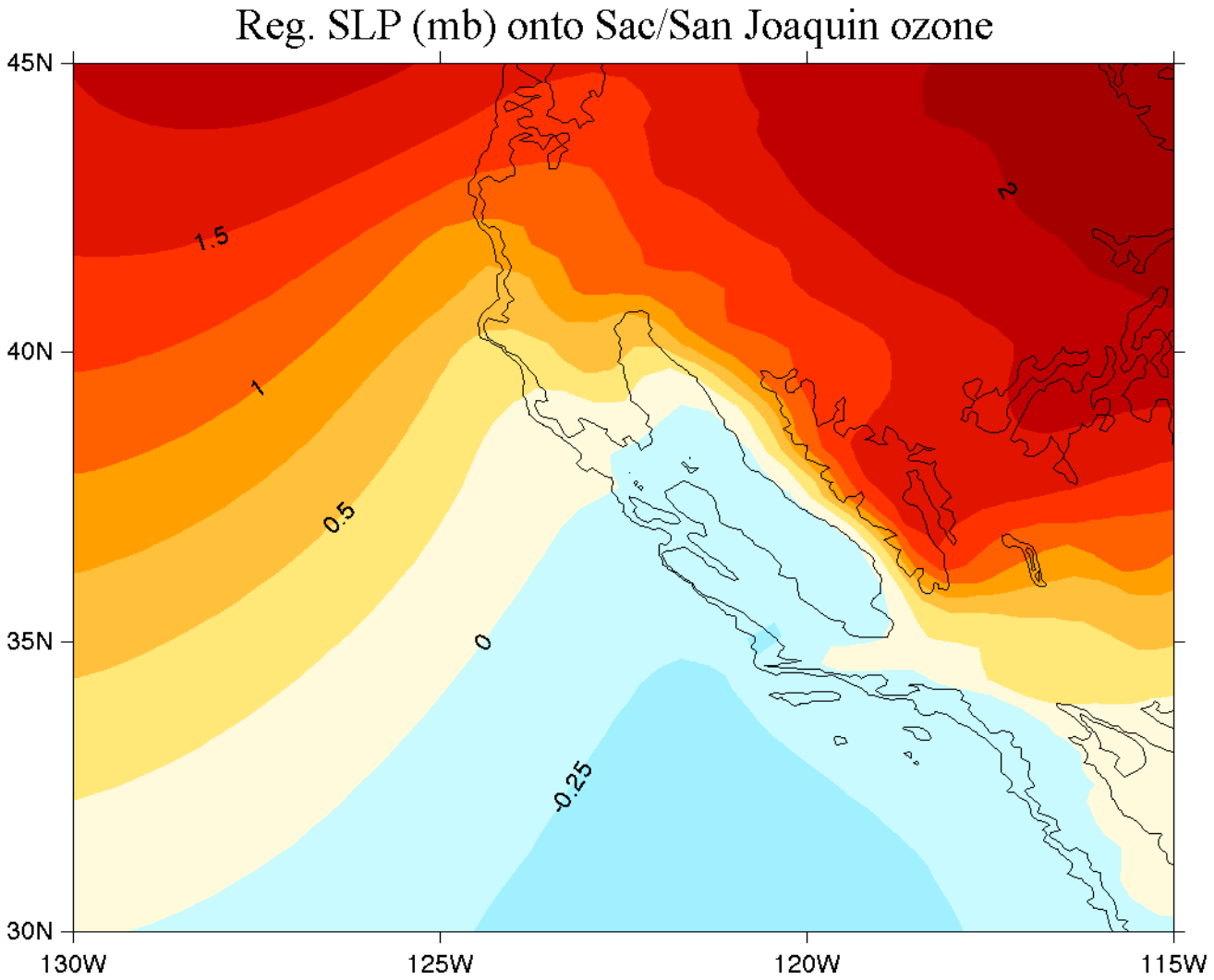
Mostly Washington State Department of Ecology measurements served by the Puget Sound Clean Air Agency

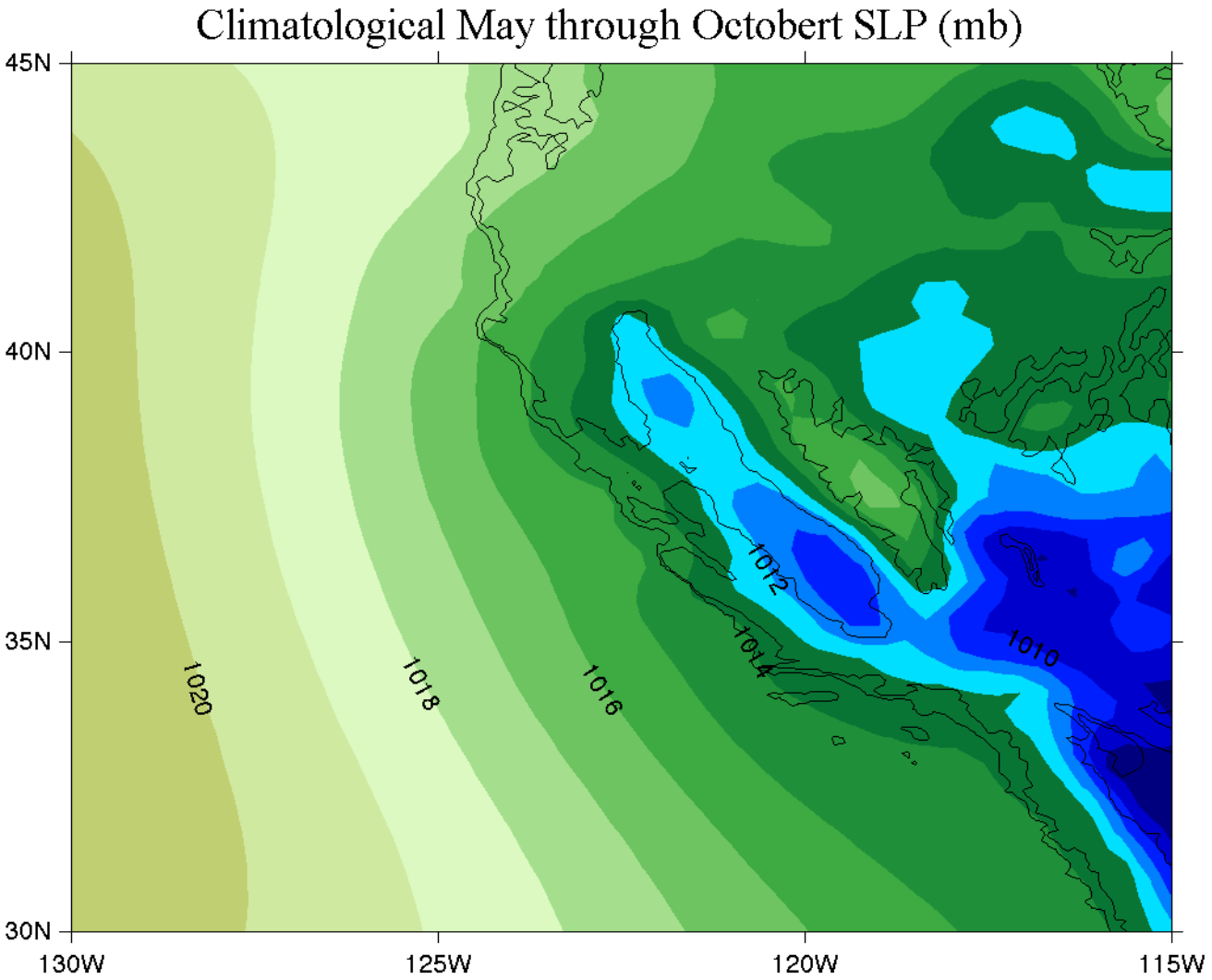

Reg. NO2 onto western Washington ozone index
(10^15 molec. cm^-2/std.dev.) 2005-09
36N
34N
32N
42N
40N
38N
36N
34N
32N
126W
124W
122W
120W
118W
116W
V
S
S
P
B
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
0, 250, and 2000m elevation contours


Reg. SLP (mb) onto western WA ozone
50N
45N
40N
35N
130W
125W
120W
115W
1.25
1
0.75
0.5
0.25
0


Climatological May through October SLP (mb)
50N
45N
40N
35N
130W
125W
120W
115W
1020
1019
1018
1017
1016
1015
1014
1012
1011


Cor. May through October ozone with state average
42N
40N
38N
36N
34N
32N
126W
124W
122W
120W
118W
116W
114W
r<0;0<r<=0.3; 0.3<r<=0.7; r>0.7

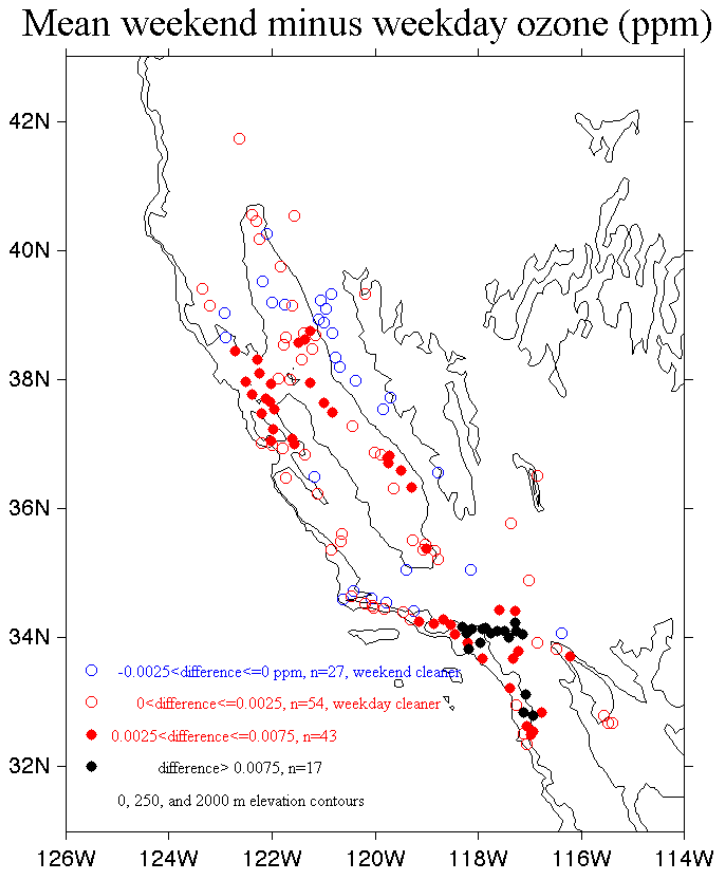

Reg. SLP (mb) onto Sac/San Joaquin ozone
45N
40N
35N
30N
130W
125W
120W
115W
2
1.5
1
0.5
0
-0.25

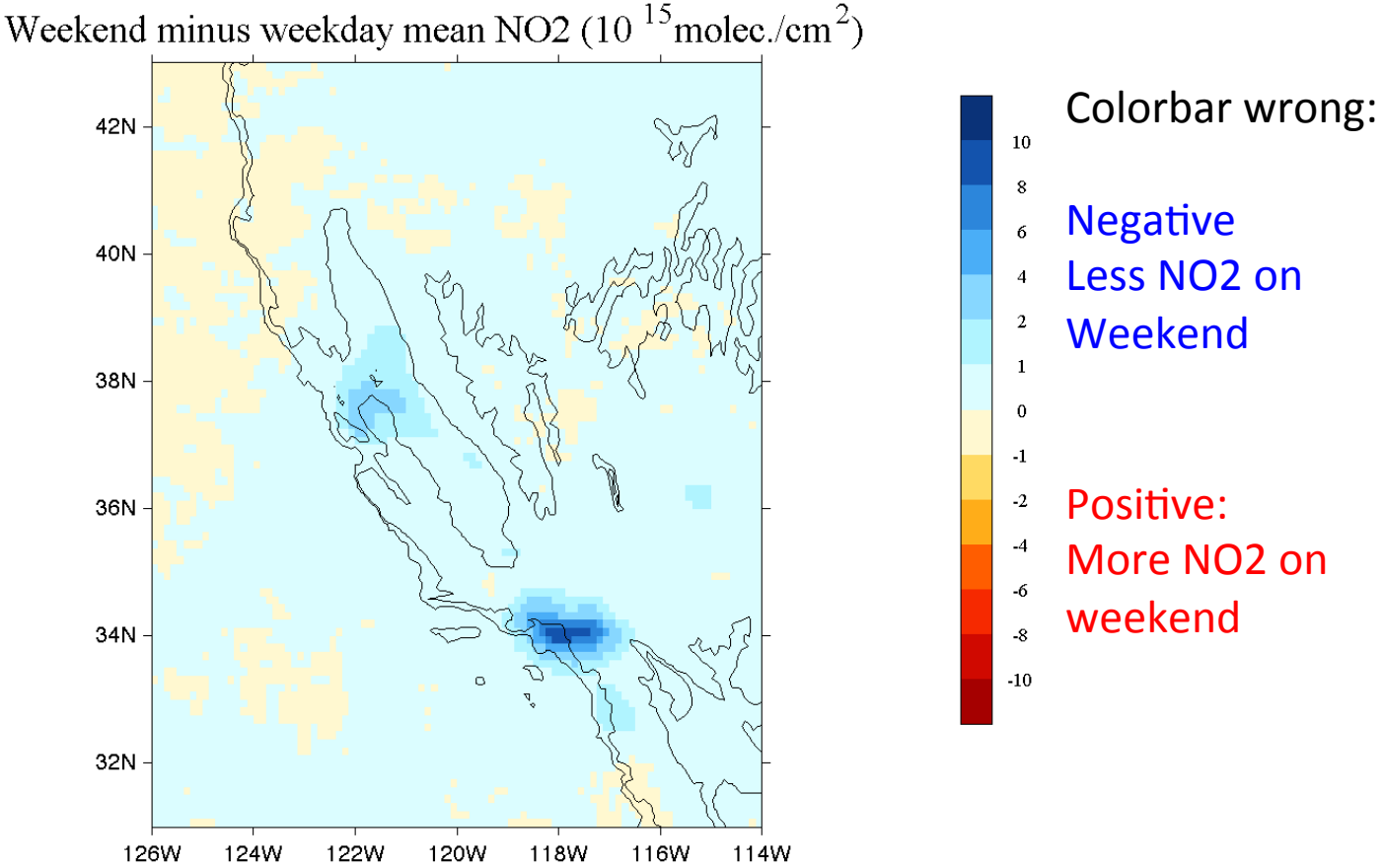

Climatological May through Octobert SLP (mb)
45N
40N
35N
30N
130W
125W
120W
115W
1020
1018
1016
1014
1012
1010

Similarity of the California and western Washington pressure anomaly patterns suggests that they are one in the same.

The California and western Washington daily mean ozone time series are correlated at 0.23 over 15 years. This correlation suggests that there is some year to year coherence of ozone variations in the two regions.

There is a significant weekday versus weekend signal in both ozone and NO_2

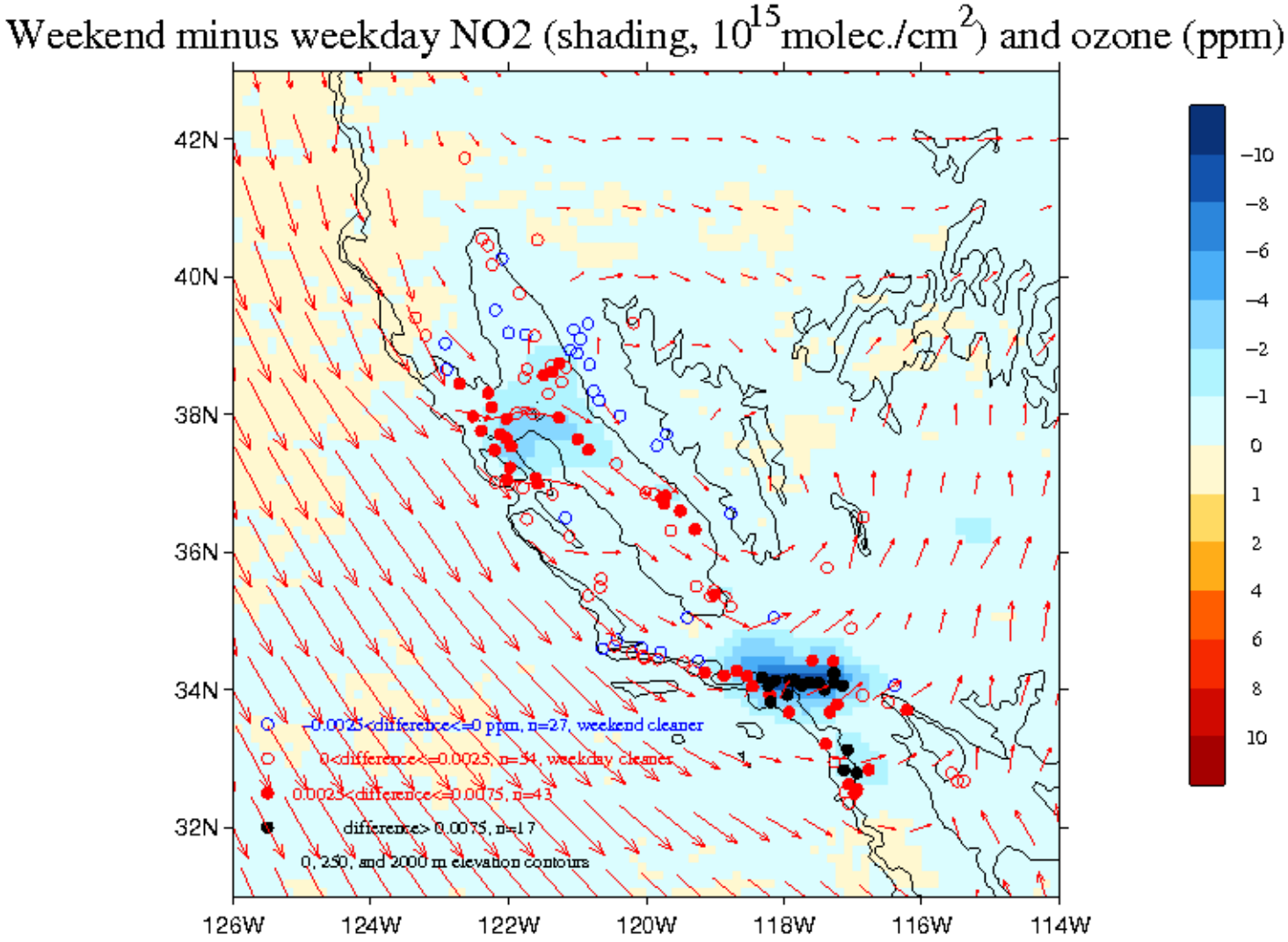


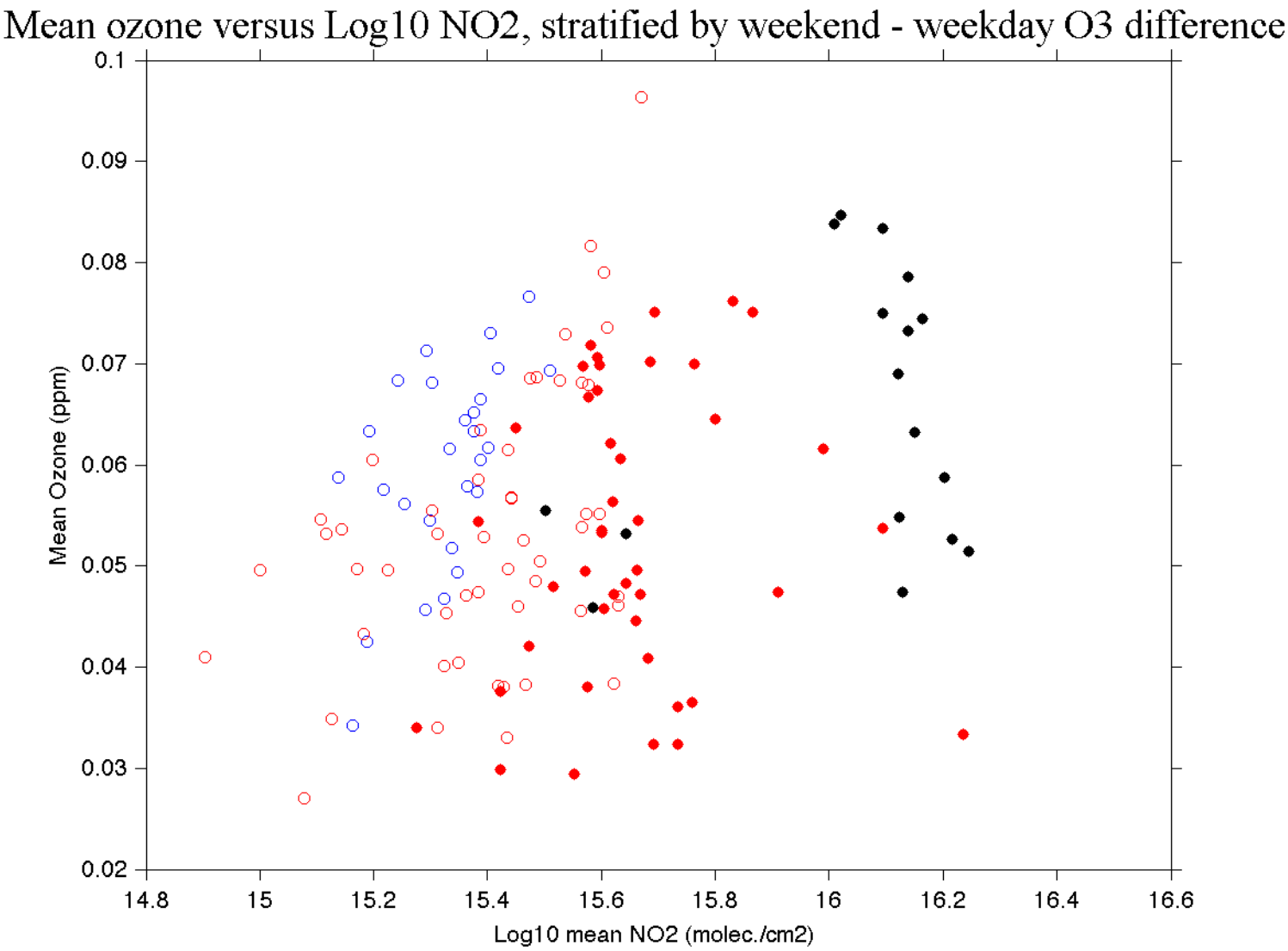


Colorbar wrong:

Negative
Less NO2 on Weekend

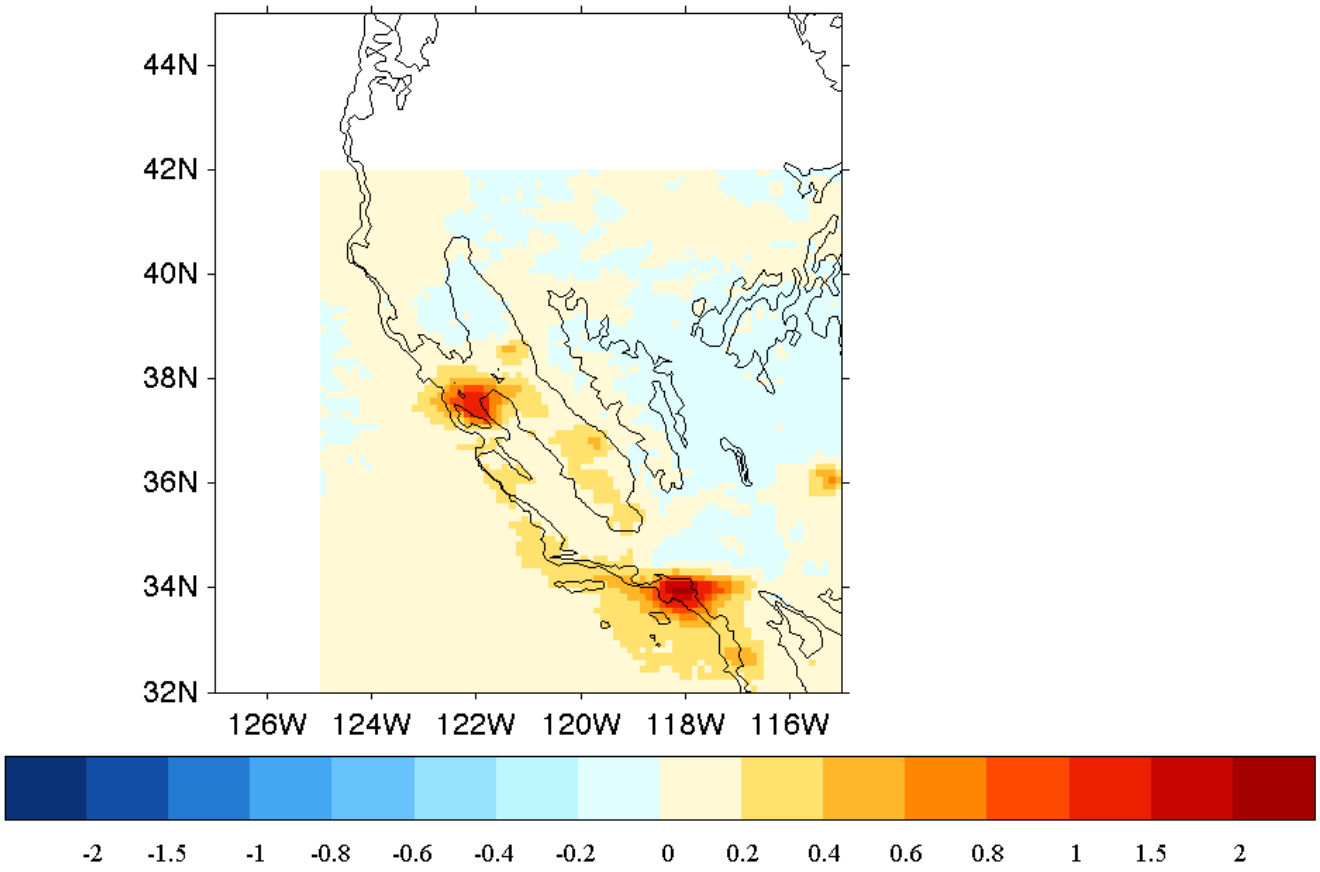
Positive:
More NO2 on weekend

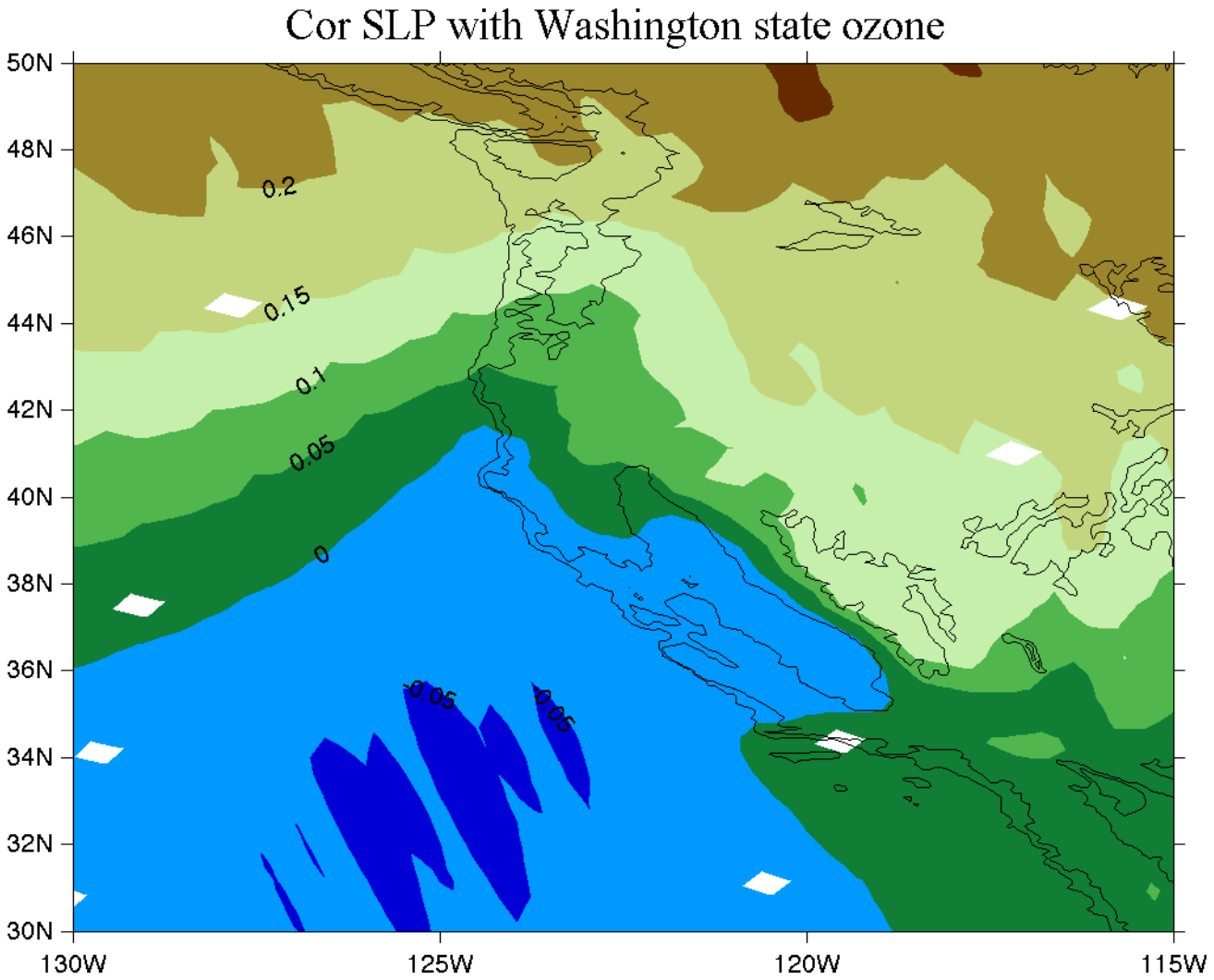

Weekend minus weekday NO2 (shading, 10^15 molec./cm^2) and ozone (ppm)
42N
40N
38N
36N
34N
32N
126W
124W
122W
120W
118W
116W
114W
-0.0025<difference<=0 ppm, n=27, weekend cleaner
0<difference<=0.0025, n=34, weekday cleaner
0.0025<difference<=0.0075, n=43
difference> 0.0075, n=17
0, 250, and 2000 m elevation contours
−10
−8
−6
−4
−2
−1
0
1
2
4
6
8
10

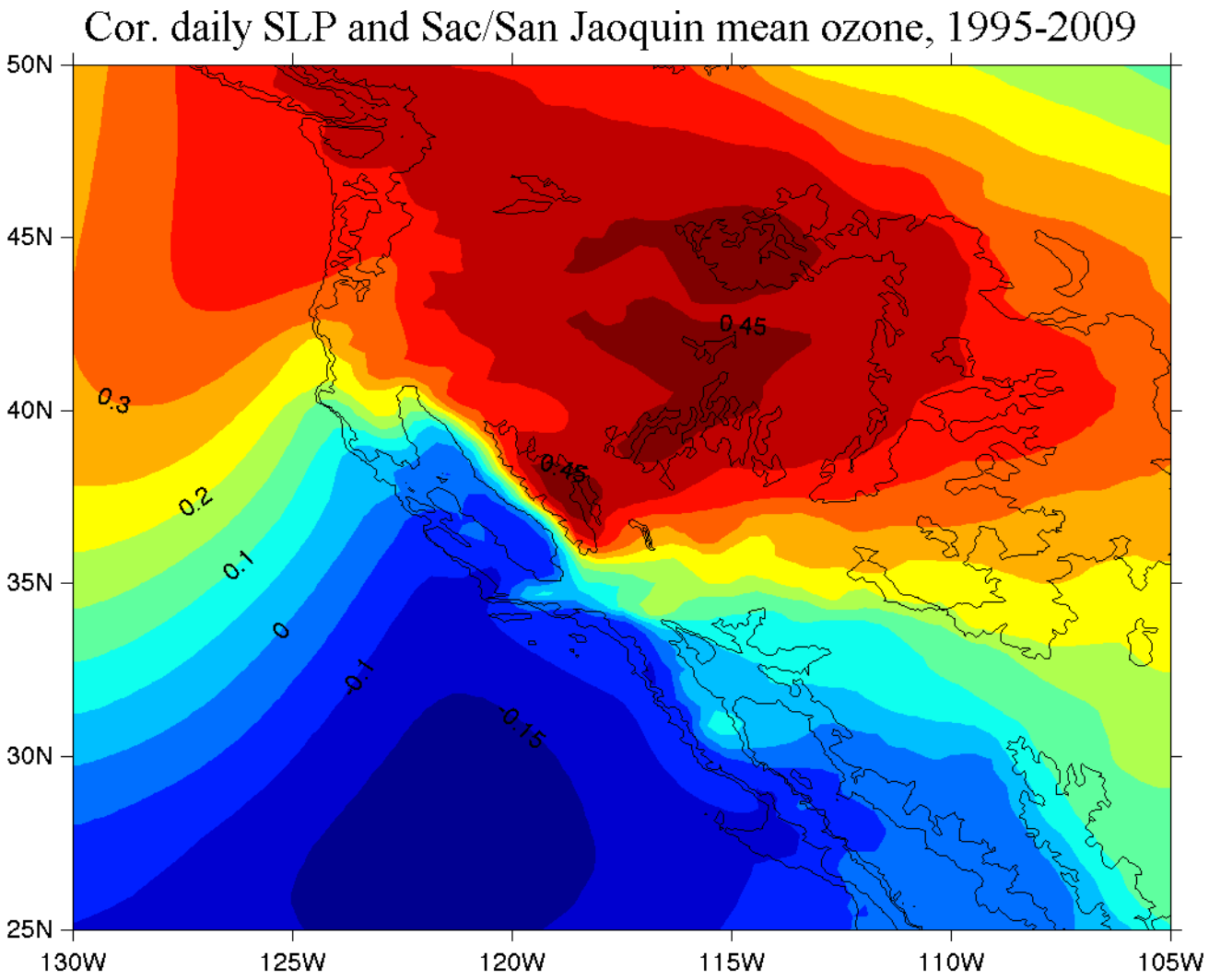

Mean ozone versus Log10 NO2, stratified by weekend - weekday O3 difference
Mean Ozone (ppm)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
14.8
15
15.2
15.4
15.6
15.8
16
16.2
16.4
16.6
Log10 mean NO2 (molec./cm2)

Reg weekday NO2 onto Sac/San Joaquin average Ozone

(10^{15} molec.cm^{-2}/std.dev.) 2005-09




Cor SLP with Washington state ozone
50N
48N
46N
44N
42N
40N
38N
36N
34N
32N
30N
130W
125W
120W
115W
0.2
0.15
0.1
0.05
0
-0.05
-0.05


Cor. daily SLP and Sac/San Jaoquin mean ozone, 1995-2009
50N
45N
40N
35N
30N
25N
130W
125W
120W
115W
110W
105W
0.45
0.45
0.3
0.2
0.1
0
-0.1
-0.15